Surveying Scientists: An American Perspective

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During the last decade several general, system-wide surveys of scientists have been accomplished, each somewhat different and each courageous in its own way. The most recent of these is the valuable contribution made by the New Zealand Association of Scientists in their 1994 effort, discussed in more detail by other contributors to this volume. Others that preceded it were two conducted by Sigma Xi, The Scientific Research Society in 1986 and again in 1988, and one by the American Association for the Advancement of Science (AAAS) in 1993. There have been many other specialised surveys of segments of scientific communities, or which have been conducted for highly specific purposes but the four cited above are attempts to represent the views of an entire scientific community across a range of important issues. I shall comment in some detail on the Sigma Xi survey to lend perspective to the New Zealand survey.

Sigma Xi is a 110 year old global scientific research society, most of whose roughly 100,000 members are in the United States. The membership is elected on the basis of research contributions and the distribution of members by field of scientific specialisation maps closely the distribution of PhD scientists and engineers throughout the United States. The chief exception is the social sciences which are underrepresented by half. Nearly four out of five members of Sigma Xi hold a PhD and 156 members have been awarded Nobel prizes. Sigma Xi is not an elite organisation in the sense of the US National Academy of Sciences fellows, and in many respects Sigma Xi can credibly claim to represent the US scientific and engineering research community. This is a claim of some importance when policy makers or journalists seek advice or information. The AAAS, by contrast, has different membership criteria which preclude it from making the same claim as Sigma Xi but which allow it to "speak for" a wider and more popularly assembled community.

1986 Sigma Xi Survey

In 1986, as preparation for their centennial celebration, Sigma Xi chose to conduct a random survey of its membership to ascertain both the composition and the opinions of the membership on a range of issues then current in the science community. This information would inform the members and serve as points of departure for a lively debate on science policy within and without the Society. Under my direction, and with the help of many volunteers, a 36 item questionnaire was hastily developed, pre-tested, revised and administered to a one in 11 sample of the membership. Ten thousand surveys were distributed by mail and ultimately 4400 were returned. Although the response rate was lower than desired, we were gratified that the field of science of those responding was virtually identical to the membership distribution. No other post survey validation was attempted, indeed the limited financial resources allocated to the project by the Society had been virtually depleted in postal charges.

The nature of the 1986 survey was deliberately broad and aimed to illuminate three major areas: (1) the changing nature and vitality of the scientific process; (2) public trust, understanding and expectations; and (3) support and organisation of research. An example of a question or two from each area may give a flavour of the instrument. In fact, the questionnaire was composed of a number of decision forcing statements to which the scientist could react on a scale ranging from "strongly agree" to "strongly disagree." The document, *A New Agenda For Science* prepared by C. Ian Jackson, then Executive Director of Sigma Xi, stands as a valuable contribution to science policy discussions and should be referred to for a greater understanding of the survey (Jackson, 1988).

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Because of then current debates in science policy circles, which were predicated on the notion of "Science" as an existent that could be moulded and shaped at political will, the survey asked a seemingly innocuous statement: "The word science is often invoked as if it meant a particular 'thing' comprised of scientists, public and private laboratories, publications, and government agencies." For me, however, "science" connotes a process or procedure for making enquiries about our world and for evaluating the hypotheses these enquires generate. More than 95% of the respondents agreed with this statement. The reader might agree with me that not much new information was developed by this question but for the limited, but powerful audience of science policy makers to whom it was meant to inform, the emphatic nature of the response was information that could not be ignored.

Public trust in the scientific community was, and is, a matter of signal concern to American scientists, particularly after some sensational issues of fraud such as those raised in the David Baltimore matter. One worrisome aspect of science was illuminated through responses to the following statement: "Scientists engaged in nationally targeted research agendas are under pressure to produce results. Such pressure can, and does, lead to the release of selective experimental results that prematurely raise the public's expectations of eventual success." Although 74.4% of the respondents agreed with this statement, seemingly passing the blame for indiscretions on to "the system" we also made another statement which more pointedly allowed the scientists to realise their own frailties: 57% of those responding to the following statement agreed that: "There is a growing tendency for scientists to sensationalise evidence in order to receive increased public exposure and/or to generate more income for themselves." This kind of information, potentially unflattering to scientists as it was, proved interesting and impressive to journalists and science policy makers precisely because we were willing to reveal it.

Concerning the support and organisation of research, we were anxious to tackle the difficult issue of funding procedures. The following statement was made and 63% of those responding agreed that: "Procurement procedures for grants to do governmentally sponsored research depend on 'who you know.' Many requests seem to be funded primarily because the researchers are already known to and supported by the granting organisations." The purport of this was to test a widely held suspicion that not all was well with the review and award system employed by government agencies. In fact, the response to this and a few related statements were such that we were led to a very explicit exploration of the issue in the 1988 survey. To suggest that this line of inquiry was not welcomed by the science establishment in the United States only dimly characterises the response of funding agencies and many senior scientists.

1988 Sigma Xi Survey

The 1988 Sigma Xi survey was benefited greatly by the experience of the 1986 survey and the organisation of the survey and crafting of questions in 1988 was superior because we learned much from the qualitative as well as the quantitative nature of the responses in 1986. The sample size was the same as in 1986 but the response rate dropped to 35% under the weight of too many added questions. Apart from continuing certain lines of enquiry introduced in 1986, the 1988 survey was aimed at revealing something about the scientist as a person.

A prominent concern for scientists in 1986 was the public understanding of science, therefore the 1988 survey addressed aspects of this concern as background information to support an international symposium on the public understanding of science and technology held jointly by Sigma Xi and AAAS in Orlando, Florida. A battery of questions on personal views, and another on professional views, helped to reveal the scientist as a person, and questions on why individuals chose to be scientists ("intrigue with the search for truth and knowledge or straightforward curiosity" and "science was easier and/or more fun for me than other fields" combined for 52% of the responses) proved interesting to the journalists at the conference. The survey itself is too extensive to delve into, in detail, but two matters we probed proved to be particularly potent: priority setting and peer review. For a full treatment of the survey see *Sketches of the American Scientist* (Sommer and Seltzer).

The survey sought opinions on what research projects and/or funding strategies the scientist would prefer to support. A list of choices were given (percent response is shown in brackets) which included "untargeted individual research awards" (23%); biosphere/geosphere systems (19%); AIDS (16%); engineering research centres (13%); superconducting materials (9%); space station (6%); Strategic Defense Initiative (4%); human genome (4%); other (4%); and superconducting super collider (2%).

It is not surprising that individual awards would be the most popular of these "apples and oranges" funding categories which make up the fruit salad of real policy debate, but specification of the superconducting super collider (SSC) at the bottom caused deep concern in the US Department of Energy. It must be noted ironically that the congressional budget process, in 1988, yielded a virtual inverse ordering of the priorities of the scientists, but it must also be noted that within four years the SSC was discontinued.

Peer review was a prominent issue in 1986, and in 1988 we made the following statement (results shown in parentheses): "The greatest concern(s) I have with respect to the use of peer review in the grant awarding process is (are): Reviews are marred by cronyism, old boys networks and insider politics" (32%); "Original, non-mainstream ideas are unlikely to be funded" (27%); "Reviews are perfunctory, cursory, or non-substantive" (9%); "Not Applicable, I think peer review works well as it is" (8%); "Reviewers are not expert in applicant's field" (8%); "Reviews are conflicting" (5%); "Award decisions are inconsistent with the reviews" (5%); "Original ideas are sometimes 'appropriated' or 'leaked' by a reviewer or program officer" (5%); "Other" (1%).

With few exceptions, the uniformity of concern among scientists regarding these rankings is striking. Women were

half as likely as men to agree that peer review works well as it is, and scientists in the 30 to 39 year old age group (where most of the women scientists were found) are especially critical of the procedure. As one would expect, concerns about cronyism decline steadily with age (one does not get to be an "old boy" for nothing!). Tenured academicians are more inclined to believe that the peer review system works and to attribute shortcomings to technical rather than venal reasons (Well, you would expect them to say that, wouldn't you!).

Both the priority setting and peer review findings touched a raw nerve and considerable grumbling and search for errors in the survey methodology ensued. There were methodological weaknesses resulting from low funding levels and simple errors, which we readily acknowledged, but a post-survey validation procedure had been followed that assured us the non-respondents were randomly distributed by field of specialisation, age, sex and income level, therefore we were more comfortable with the "uncomfortable" results than were its detractors. So too was the United States Congress pleased with the survey. They read the results into their official record and the chairman of the House of Representatives Science, Space and Technology Committee requested a special report from Sigma Xi to identify "the crucial issues the House should debate in the 104th Congress."

Some Results

These surveys did four main things: first, they provided information the Society might use to serve its membership better, for example, the choice of themes for their annual meetings for several years were guided by the results; second, the survey provided a voice for the science community in policy matters at the highest level without lobbying for a cause or money; third, public understanding of science was enhanced through coverage of the results and through publications, for general consumption, by the Society; and fourth, the survey instrument, and then the results of the survey itself, served as an alert system for the members of the Society to issues of national importance.

I have emphasised the matter of not lobbying because the Society can, and did, achieve more by being the honest broker of information, rather than by making a frontal assault on the funding agencies or other institutions. Admittedly, some of the information was subversive, but those who were ired by the results were welcome to ask the questions themselves or to provide alternative explanations of the results. Because we were willing to publish results that were unflattering to scientists rather than trying to hide these or ignore their meaning, the survey gained credibility with decision makers.

1993 AAAS Survey

Briefly, in 1993 the AAAS undertook a survey of 3000 members of its organisation, which is somewhat larger than Sigma Xi. The survey was more focussed on organisation issues and there were fewer and generally better crafted questions than those done earlier by Sigma Xi. The response rate was 59%, reflecting the brevity of the survey instrument and a better financed set of procedures to follow up with non-respondents. There were similarities to the earlier Sigma Xi surveys in the way information on the composition of the members was gathered, eg women represented 15% of the AAAS random survey as they did in the Sigma Xi surveys. This is a percentage point or two lower than that of women in science in the US and comports with the New Zealand Association of Sciences percentage (16%).

Some Observations on the 1995 NZAS Survey

What do we make of the Sigma Xi surveys with respect to the NZAS survey? First, it seems to me that the 1986 Sigma Xi survey and the NZAS survey had much in common: they were done with all haste, using volunteer forces and running on a tiny budget. Both did very well under the circumstances. Without being fully appraised of the methodology NZAS employed, it is my understanding that it like the 1986 survey, did not do extensive pre-testing of the instrument due to time and money constraints. There is, however, no replacement for protesting even if one has successful past surveys upon which to build. It is gratifying to know that successive survey attempts can build on the past and I expect that will be the case in the future in New Zealand.

NZAS suffered a population problem unlike that of Sigma Xi: who knows who and where the scientists in New Zealand are? The answer is that there is no fully useable listing at this time, although there is every evidence that The Royal Society of New Zealand has a head start in building a comprehensive list on a very flexible data base system. Should this be accomplished it will be a benefit to many segments of the New Zealand science community and will greatly enhance surveying capabilities. Even with a list, it will be necessary to determine the subset which might best meet the objective of the survey to be taken because, as we have seen with Sigma Xi, the 1986 and 1988 surveys had different themes while they retained many core questions from which continuity and trend lines could be developed. A flexibly developed data base will permit stratification for different groups, a procedure used effectively in the AAAS survey and one that will be especially important in New Zealand, given the small size of the scientific community. The NZAS survey, while dealing with special subset groups in its 1995 effort, did not actually stratify a sample or develop a random sample, thus giving room for critics to dismiss results.

Both the NZAS and the Sigma Xi surveys took on some tendentious issues and developed some valuable information around them. Because the missions of the two organisations differ: Sigma Xi is an honour society whose sole objectives are to promote communication and companionship among scientists across disciplinary boundaries, and NZAS has several portfolios including "influencing government policy", it is natural that they would approach their surveys differently. Whereas Sigma Xi published its results and brought them to the attention of the press and any interested parties without comment, NZAS was explicit in drawing conclusions about government policy from the results. In this sense

it is difficult to compare the effectiveness of the different organisations, but I would note that despite goring several sacred oxen of science, Sigma Xi was asked to give its advice to government on what are the important issues to debate, not on what are the answers the debate should yield.

Future surveys in New Zealand should build on the experience of the NZAS, particularly where some valuable lines of enquiry have been initiated. For example, the effort to gauge how scientists spend their time is important even though it is notoriously hard to get accurate readings from individuals, especially when they are asked to compare what they did in some previous period with what they are doing in a subsequent period. The accounting is not reliable. This needs to be continued and to be improved. By contrast, it is probably not worth pursuing the "basic to applied to development, etc. shift" in the form of the NZAS survey simply because scientists themselves have very different views of what the terms means.

Future surveys should try to establish the objectiveness of the intent of the instrument and of those carrying out the enquiry. The questions should be as tough and revealing as they can be, but the totality of the instrument must not be seen to attack one segment of the science community unfairly. There is plenty that needs remedy on all sides and a willingness to expose scientific "warts" as well as "halos" will gain respect for results.

Howsoever future surveys are conducted, they should be carefully integrated into other frameworks so that the data collection or coding can be comparable with, for example, the appropriate New Zealand census categories for age or income, etc. and for overseas scientific categories such as European Community data collection frameworks. This will open up the New Zealand results to a wider range of interested parties and to the kind of valuable criticism that will serve to improve future efforts. An excellent beginning has been made in the NZAS survey and future work must take account of that effort.

References

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